INVESTIGATING THE ACCURACY OF THREE GEODETIC DATUM TRANSFORMATION SOFTWARE FOR APPLICATION BETWEEN WGS84 AND MINNA DATUMS

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❑ **INTRODUCTION**

o GNSS/GPS Observation

o Existing Control Stations

❖ **Datum Transformation/Conversion Software**

o Columbus software

o GeoCalc Software

o AllTrans Software

❖ **Objective of the Study**

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❖ The Nigeria Geodetic Datum Parameters

o Ellipsoid: Clarke 1880 ($a = 6378249.145$m, $f = 1/293.465$).

o Station Name: L40 (latitude 9°38'08.87"N and longitude 6°30'58.76"E.

o Orthometric height of station L40 = 281.13m.

❖ Transformation between WGS84 and Minna Datums

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{Minna} = \begin{pmatrix} T_X \\ T_Y \\ T_Z \end{pmatrix} + (1 + \Delta S) \begin{pmatrix} 1 & R_Z & -R_Y \\ -R_Z & 1 & R_X \\ R_Y & -R_X & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{WGS84}$$

(1)

❖ **Conversion between Geodetic and Cartesian Rectangular Coordinates**

$$X = (N + h)\cos\varphi\cos\lambda$$
$$Y = (N + h)\cos\varphi\sin\lambda$$
$$Z = \left[N(1 - e^2) + h\right]\sin\varphi$$

(2)

Where

,

$$N = \frac{a}{(1 - (2f - f^2)\sin^2\varphi)^{\frac{1}{2}}}$$

(3)

$$f = \frac{a - b}{a}$$

(4)

4

Cartesian to Geodetic

$$\varphi = \tan^{-1}\left[\frac{Z}{\sqrt{X^2 + Y^2}}\left(1 - e^2\left(\frac{N}{N+h}\right)\right)^{-1}\right] \quad (5)$$

$$\lambda = \tan^{-1}\left[\frac{Y}{X}\right] \quad (6)$$

$$h = \sqrt{X^2 + Y^2}.\sec\varphi - N \quad (7)$$

Where,

$e^2 = $ Eccentricity squared $= 2f - f^2$

$N = $ radius of curvature as given in equation (3)

The Nigeria West Belt parameters

- o Latitude Origin: 4° 00′ 00"
- o Longitude Origin: 4° 30′ 00"
- o False Northing: 0mN
- o False Easting: 230738.266mE
- o Scale Factor: 0.99975

Transformation Parameters from WGS 84 to Minna Datum

Tx = 93.809786m ± 0.375857310m
Ty = 89.748672m ± 0.375857310m
Tz = -118.83766m ± 0.375857310m
Rx = 0.000010827829 ± 0.0000010311322
Ry = 0.0000018504213 ± 0.0000015709539
Rz = 0.0000021194542 ± 0.0000013005997
S = 0.99999393 ± 0.0000010048219

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❑ **METHODOLOGY**

❖ **Data Acquisition**
- GNSS Observation of four points (FGPEDY33, ESO 1, ESO 2, ESO 3, ESO 4 and ESO 5)

Table 1: Geographic and Rectangular Coordinates of the Points

STATION	WGS84		MINNA (CLARKE ELLIPSOID)	
	LATITUDE	LONGITUDE	NORTHING (m)	EASTING (m)
SEO01	6° 16' 42.97323"	5° 38' 12.00033"	251980.6255	356579.8098
SEO02	6° 16' 36.54880"	5° 38' 10.50577"	251783.1869	356534.3011
SEO03	6° 16' 33.29440"	5° 38' 11.79138"	251683.3076	356574.0325
SEO04	6° 16' 28.62157"	5° 38' 11.27213"	251539.7379	356558.3840

Data Processing

Figure 1: Transformation and Conversion of the Global Geographic Positions to Minna Datum Rectangular Coordinates Using Columbus Software
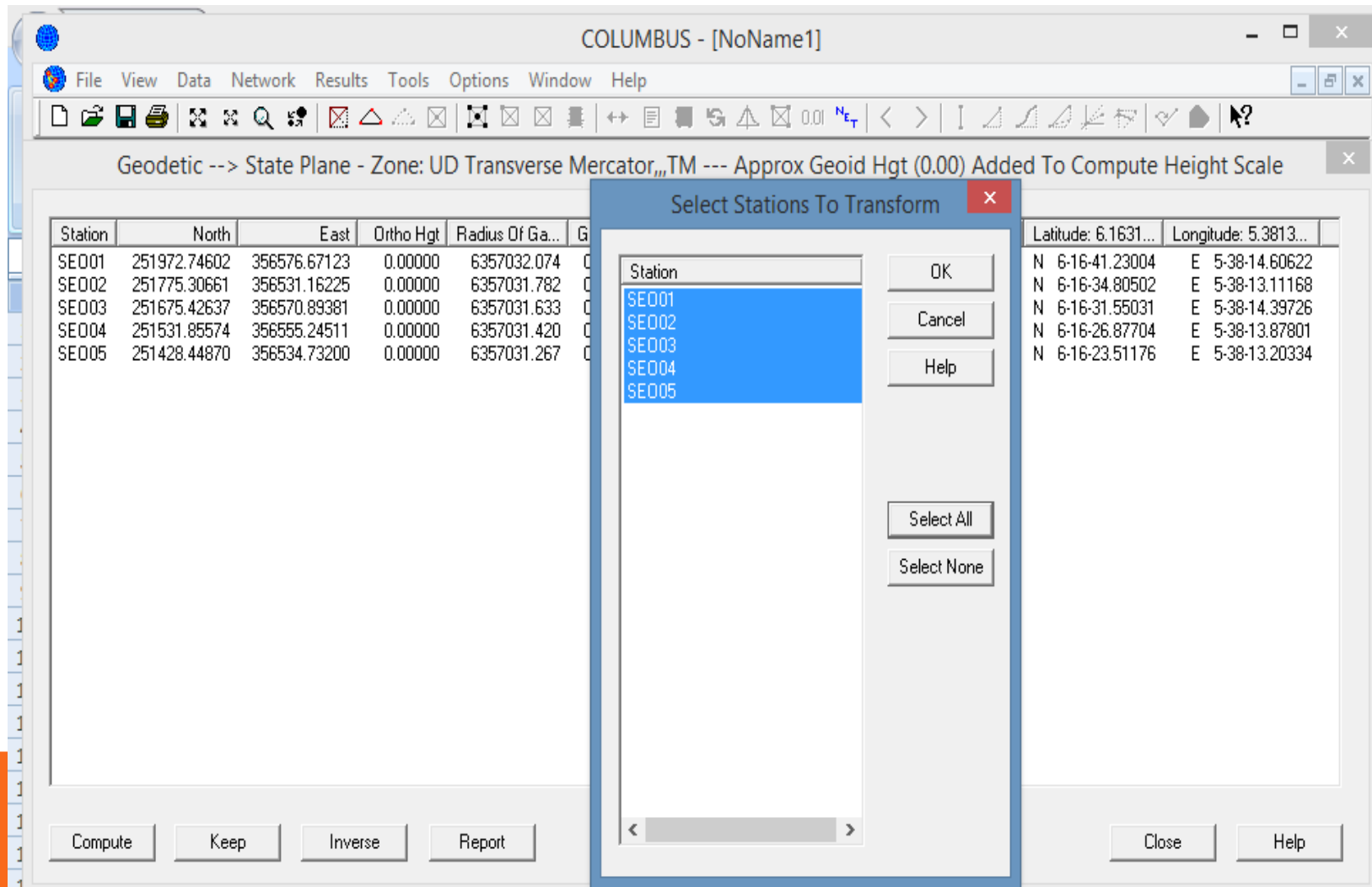
Figure 2: Transformation and Conversion of the Global Geographic Positions to Minna Datum Rectangular Coordinates Using AllTrans Software
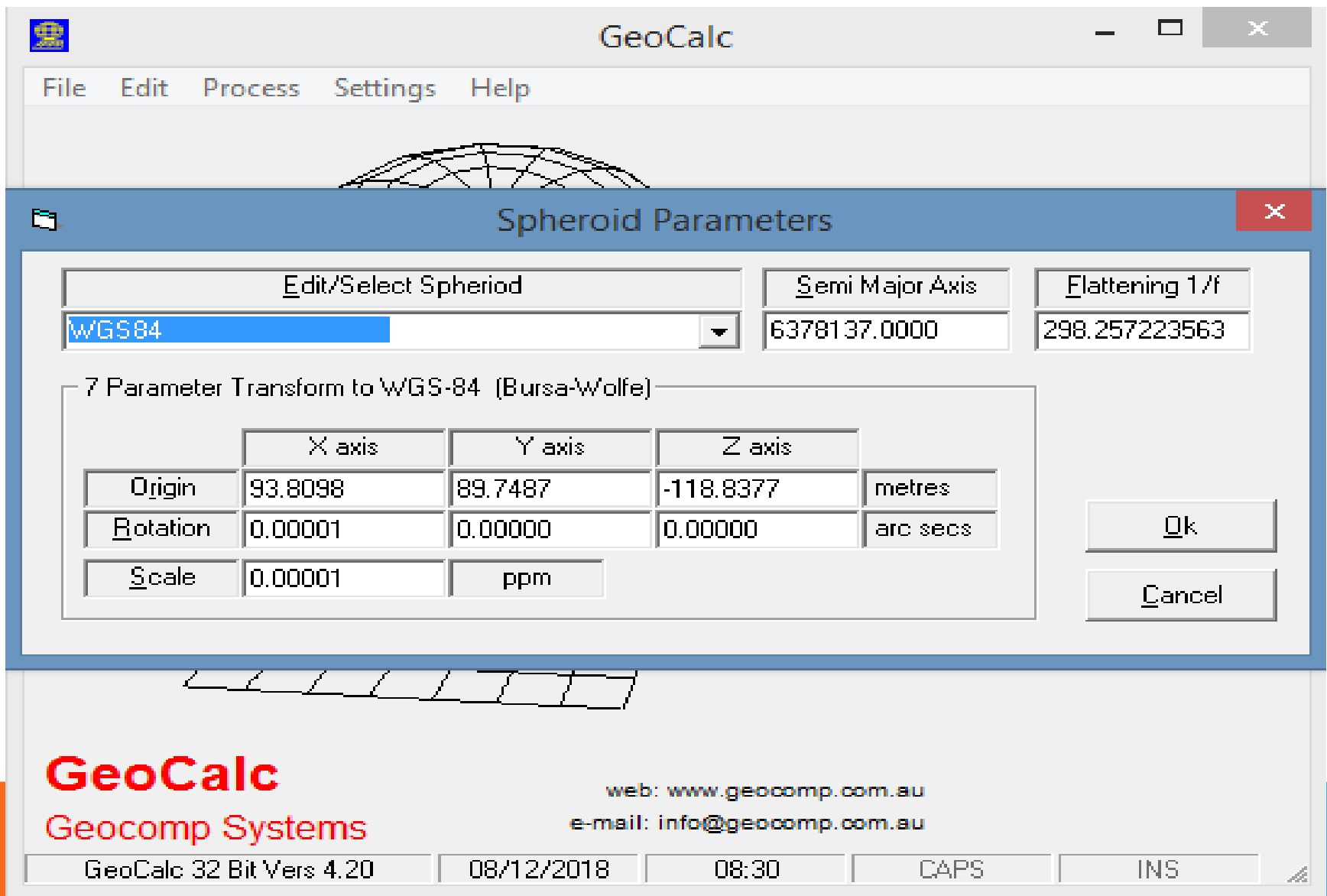
Figure 3: Transformation and Conversion of the Global Geographic Positions to Minna Datum Rectangular Coordinates Using GeoCalc Software

❖ Results Presentation and Analysis

Table 2: Rectangular Coordinates of the Points Obtained Using   Compass, Columbus, AllTrans and GeoCalc Software

STATION	MINNA (CLARKE ELLIPSOID)							
	COMPASS		COLUMBUS		GEOCAL		AllTrans	
	NORTHING (m)	EASTING (m)	NORTHING (m)	EASTING (m)	NORTHING (m)	EASTING (m)	NORTHING (m)	EASTING (m)
SEO01	251980.6255	356579.8098	251972.7460	356576.6712	251694.8359	356577.2335	251972.7458	356576.6655
SEO02	251783.1869	356534.3011	251775.3066	356531.1622	251497.3962	356531.7258	251775.3061	356531.1564
SEO03	251683.3076	356574.0325	251675.4264	356570.8938	251397.5156	356571.4573	251675.4260	356570.8881
SEO04	251539.7379	356558.3840	251531.8557	356555.2451	251253.9453	356555.8070	251531.8555	356555.2395
SEO05	251436.3314	356537.8708	251428.4487	356534.7320	251150.5368	356535.2960	251428.4484	356534.7263

Table 3: Points Coordinate Differences between Compass and   the Datum Transformation Software

STATION	COLUMBUS		GEOCAL		AllTrans	
	DIFF. IN NORTHING (m)	DIFF. IN EASTING (m)	DIFF. IN NORTHING (m)	DIFF. IN EASTING (m)	DIFF. IN NORTHING (m)	DIFF. IN EASTING (m)
SEO01	7.8795	3.1386	285.7896	2.5763	7.8797	3.1443
SEO02	7.8803	3.1389	285.7907	2.5753	7.8808	3.1447
SEO03	7.8812	3.1387	285.7920	2.5752	7.8816	3.1444
SEO04	7.8822	3.1389	285.7926	2.5770	7.8824	3.1445
SEO05	7.8827	3.1388	285.7946	2.5748	7.8830	3.1445
MEAN			285.791			

Reference factor	
x(north)Move(Offset)	7.9016 m
y(east)Move(Offset)	3.1438 m
Scale	0.0000ppm
Rotate	0.0000 s

3.2 2D adjustment distance

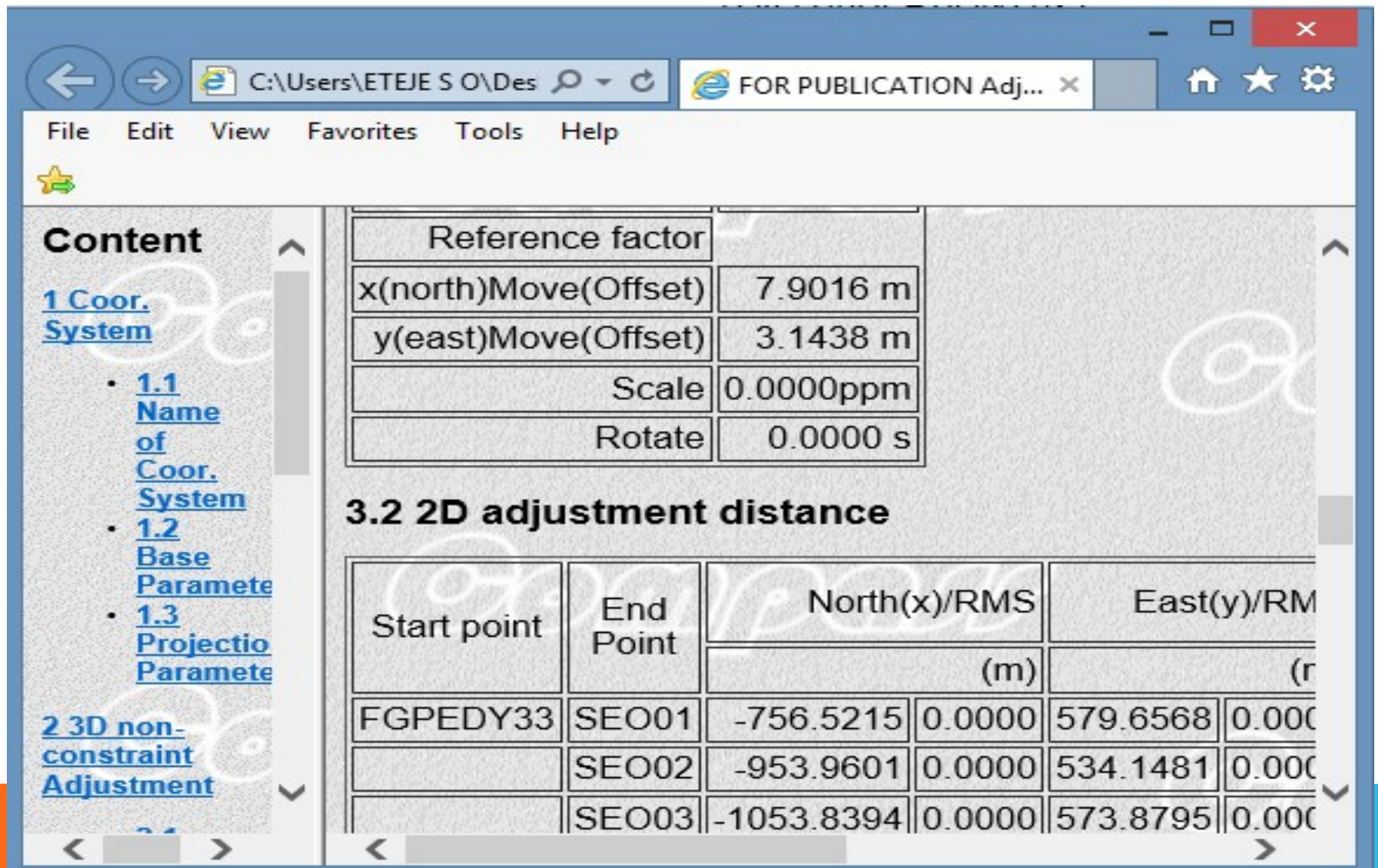| Start point	End Point	North(x)/RMS		East(y)/RM
		(m)		(m
FGPEDY33	SEO01	-756.5215	0.0000	579.6568	0.000
	SEO02	-953.9601	0.0000	534.1481	0.000
	SEO03	-1053.8394	0.0000	573.8795	0.000

Figure 4: Errors/Offsets in Northing and Easting of Compass Software Positions

Table 4: Differences between Offsets and Mean Differences in Positions

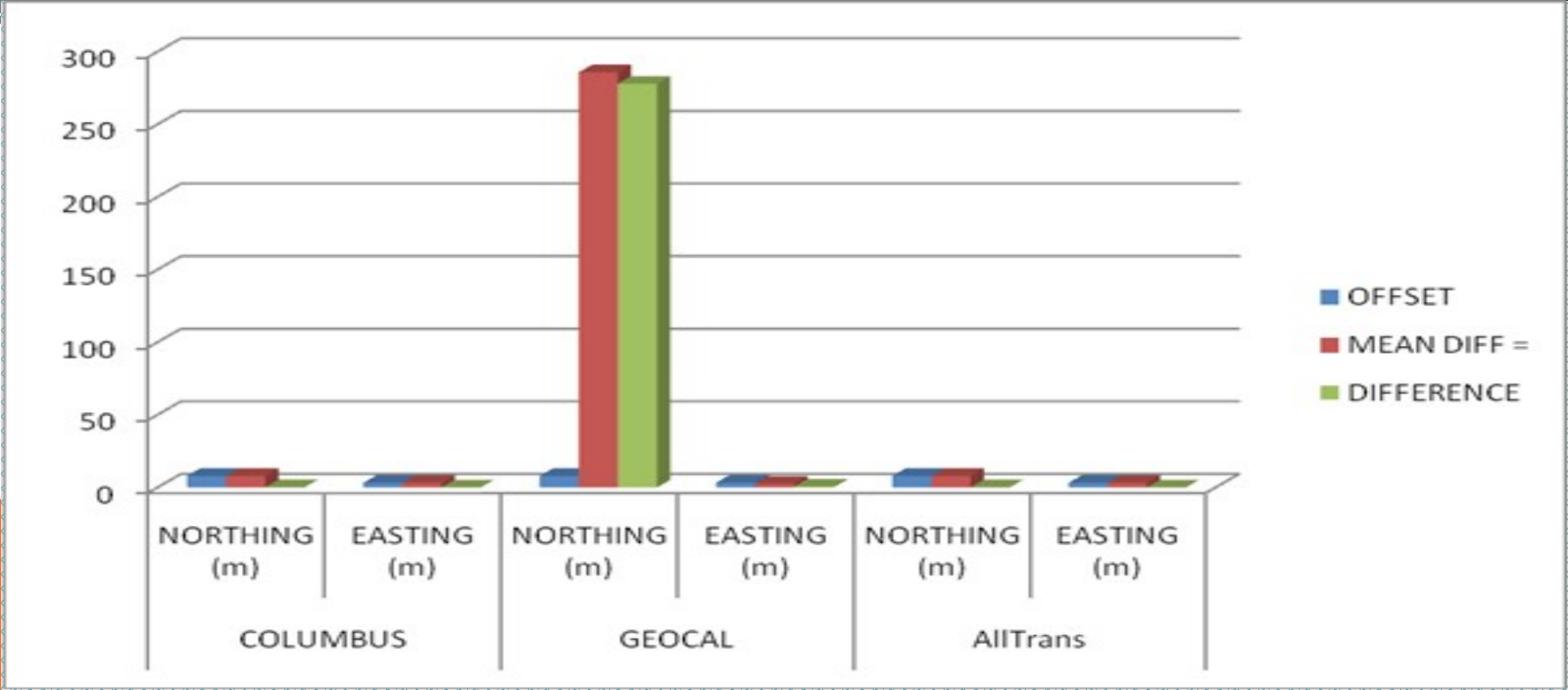| SOFTWARE	COLUMBUS		GEOCAL		AllTrans	
COORDINATE	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING
OFFSET	7.9016	3.1438	7.9016	3.1438	7.9016	3.1438
MEAN DIFF	7.8812	3.1388	285.7919	2.5757	7.8815	3.1445
DIFFERENCE	0.0204	0.0050	-277.8903	0.5681	0.0201	0.0007

Figure 5: Plot of Differences between Compass Coordinates Offsets and   Mean Differences in Positions

❑ **CONCLUSION**

o The study has successfully compared three geodetic datum transformation software (Columbus, AllTrans and GeoCalc).

o Recommended two (Columbus and AllTrans) for application between WGS 84 and Minna Datum.

THANK YOU FOR LISTENING
AND
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